REPORT

Irongate Industrial Plan Change Stormwater Options Assessment

Prepared for Hastings District Council

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QUALITY ASSURANCE STATEMENT

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REVISION SCHEDULE

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01	19/12/08	Draft Stormwater Report for Internal Review	Amon Martin	Wayne Hodson and Brian Kouvelis	Tim Grace
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HASTINGS DISTRICT COUNCIL

Irongate Industrial Plan Change
Stormwater Options Assessment

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1 Introduction

The following assessment considers the feasible options available for the management of stormwater in the new industrial area proposed in the vicinity of Irongate Road and Maraekakaho Road in Hastings. The assessment has a focus on the use of low impact solutions such as on site treatment and disposal and swales and attenuation prior to discharge to surface water courses.

The design approach taken for the proposed new industrial area is intended to ensure that future development takes place in accordance with accepted sustainable stormwater management practices.

1.1 Background

The Strategic Development Group of the Hastings District Council (the Council) is currently preparing a plan change to rezone land in the Irongate area for industrial purposes. In order to support the proposed plan change the Council requires an assessment of the stormwater management options and stormwater service constraints associated with the future development of the area for industrial purposes. The proposed plan change stems from the Council's broader industrial review which commenced early in 2000.

In September 2003 the Council adopted the recommendations of the district wide *Industrial Site Selection Report* and endorsed the associated strategy. The areas identified as being most suitable for industrial rezoning were the Omahu Road Strip (for high profile dry industry uses), the Irongate Cluster (for larger scale dry industry uses) and the Tomoana Extension (for wet industry uses that require access to the trade waste sewer).

As part of the 2006 Long Term Council Community Plan (LTCCP) process the Council decided to defer any infrastructure construction and hence the rezoning of the Tomoana Extension area until after 2016 due to the existing capacity for wet industry in the current Whakatu industrial zone. The subsequent investigations have therefore focused on the Omahu Road Strip and Irongate Cluster areas.

The Council has now decided to move forward with the notification of a plan change for the Irongate Cluster area and requires detailed area specific assessments to be completed on the basis of the most recent decisions in relation to the possible extent of the proposed new industrial area. The area that is being considered for rezoning is shown on the Final Staging Plan contained in Appendix 1

1.2 Scope of Assessment

This assessment provides an overview of the most feasible stormwater management options for the proposed new industrial area and the associated rough order costs for the implementation of the recommended option.

This assessment includes:

- consideration of the effect of future industrial development on stormwater runoff;
- constraints for the management of stormwater in the proposed plan change area;
- consideration of potential for impacts to the aquifer and related stormwater quality treatment requirements;
- review of overland flow options;
- identification of feasible stormwater management options;
- rough order costs for the recommended stormwater management option;
- identification of the preferred stormwater management solution.

1.3 Previous assessments and relevant reports

The following assessments and reports have been reviewed as part of this assessment.

- Stormwater Management: Guidelines for the Hawke's Bay Region - Draft, October 2008, Hawke's Bay Regional Council (these guidelines were initially produced in draft form but following discussions with HBRC were considered appropriate for use prior to release of the final version in April 2009).
- Hawke's Bay Waterway Guidelines - Stormwater Management, April 2009, Hawke's Bay Regional Council.
- Irongate Industrial Plan Change Preliminary Geotechnical Assessment - Draft, October 2008, MWH New Zealand Limited.
- Southern Expressway Extension: Flaxmere to Longlands, Hydrologic and Hydrodynamic Analysis, April 2008, Hawke's Bay Regional Council.
- Hastings District Council – Engineering Code of Practice for Subdivison and Development, November 1997, Hastings District Council.
- Hastings District Council Water Services Bylaw 2009, Hastings District Council.
- On Site Stormwater Management Manual, Auckland City Council, 2002.
- Soakage Design Manual, Auckland City Council, February 2003.
- Preparing for climate change – A guide for local government in New Zealand, Ministry for the Environment, July 2008.
- Climate Change Impacts on High Intensity Rainfall in the Hastings District, NIWA, October 2006.

2 Design Objectives

The design objective is to provide for an appropriate stormwater solution in the proposed new industrial area with a focus on the use of low impact options such as on site stormwater treatment and disposal and swales and attenuation prior to discharge to surface water courses. This objective is to be achieved while meeting both the Council and the Hawke's Bay Regional Council (HBRC) design guidelines as outlined below.

2.1 Hastings District Council – Design Guidelines

The following guidelines have been taken from Hastings District Council – Engineering Code of Practice, November 1997.

- The primary Stormwater system of pipes and/or open watercourses shall have sufficient capacity to convey a 5 year storm without surcharging.
- For rainfall in excess of a 5 year storm up to a 50 year rainstorm, the secondary stormwater system shall have sufficient capacity to discharge runoff and protect buildings and household gully traps from inundation.

In addition a review of the Hastings District Council Water Services Bylaw 2009 has been undertaken and relevant sections taken into account.

2.2 Hawke's Bay Regional Council

Consultation with HBRC has been ongoing throughout the stormwater options assessment process. During this possess the Hawke's Bay Waterway Guidelines - Stormwater Management were produced by HBRC, first as a draft and then as a final version in April 2009. These guidelines have been key in providing guidance for design and assessment of the various options. The guidelines also allowed design objectives to be refined.

Through consultation with HBRC an understanding of the flooding issues surrounding the receiving environments of Sisson Drain, Irongate Stream and the Karamu River were obtained. These issues have been confirmed as follows:

- Localised flooding in the vicinity of Sisson Drain at the Maraekakaho Road/Proposed Southern Expressway Extension is of ongoing concern.
- No significant flooding issues exist at the Irongate Stream immediately downstream of the proposed plan change area.
- The Karamu Stream has ongoing flooding concerns which are addressed through the operation and maintenance of a significant flood control scheme in the area. The design and operation of the flood control scheme has taken into account the possibility of future development within the Irongate Stream and Sisson Drain catchments and their associated increases in discharge.

Due to the nature of the receiving environments the design objectives for the Sisson Drain catchment are more restrictive than those required for the Irongate Stream catchment.

The following recommendations relating to peak discharge as described in the Hawke's Bay Waterway Guidelines - Stormwater Management formed the design objectives for the Sisson Drain catchment.

- Post development peak discharge for the 100-year storm is recommended to be limited to 80% of the pre-development storm.

- For intermediate storm control it is recommended that the 2-year and 10-year post-development peak discharge not exceed the 2 and 10-year pre-development peak discharge.

Meeting these recommendations will allow the key design principal of preventing existing flood problems from getting worse to be achieved.

Through consultation with HBRC the following design considerations were also noted:

- Provide for base flow or low flow recharge following development.

- Provide water quality treatment – HBRC have highlighted specific concern relating to contamination of aquifers.

- Design storms of 2 hour duration were accepted as being appropriate for determining discharge from the proposed new industrial area.

- Design storms of 1 hour duration were considered appropriate when determining the soakage requirements for the proposed new industrial area.

A precautionary approach has been taken for the concept design of the hydraulic capacity of the swales. A design storm of 1 hour duration has been used as the basis for the concept design of swales.

2.3 Climate Change

Climate change has been addressed in line with the Ministry for the Environment guidelines as contained in the document titled Preparing for Climate Change – A Guide for Local Government in New Zealand (July 2008). These guidelines recommend that a percentage adjustment is made per degree of warming for various rainfall durations and return periods. Following a review of the recommendations contained in these guidelines an adjustment of 16% has been made to all rainfall intensities relating to the stormwater requirements within the proposed new industrial area. The adjusted rainfall intensities are shown in Table 3: Rainfall for Irongate Area (in mm, from TP19 + 16%).

The use of rainfall from TP19 + 16% (to allow for climate change) may be described as conservative. However it is considered appropriate at the rezoning stage for the design to take a conservative approach. It is noted that the NIWA report Climate Change Impacts on High Intensity Rainfall in the Hastings District (October 2006) indicates lower percentages increases for climate change for various return periods and durations. A review of the increase due to climate change and the rainfall intensities generally may be appropriate during detailed design.

3 Boundary Conditions

3.1 Proposed Plan Change Area

The stormwater assessment relates to areas within the Irongate Stream and Sisson Drain catchments as shown in Appendix 1. As the stormwater option assessment process evolved various rezoning and staging scenarios have been considered. As a result a number of combinations of areas have been assessed throughout this process. These changes in areas have been accounted for in the various option design calculations.

3.2 Natural Catchment Boundaries within the Plan Change Area

A review of the Lidar contours has identified a natural catchment boundary within the plan change area (refer to Appendix 2). Runoff from the Sisson catchment naturally falls from north to south and discharges to the Sisson Drain. The Sisson Drain catchment contains approximately 57.5% of the total area being considered for rezoning. The other areas naturally discharge to the Irongate Stream. These areas make up the remaining 42.5% of the total area considered for rezoning.

The total area being considered for possible rezoning is some 110 hectares. The plan change area is contained in both the Sisson Drain and Irongate Stream catchments and has been divided into Stage 1, Stage 2 and Other Areas (areas subject to further consideration). These areas are shown in Appendix 1 and are listed in the table below.

Table 1: Catchment Areas

	Area (ha)	Area (%)
Stage 1 (Irongate Stream Catchment)	32.65	29.6
Stage 1 (Sisson Drain Catchment)	11.15	17.2
Stage 2 (Sisson Drain Catchment)	38.2	34.6
Other Areas (Irongate Catchment)	14.2	12.9
Other Areas (Sisson Drain Catchment)	6.3	5.7
Total Area	**110.3**	**100%**

3.3 Existing Roadways and Swales

Runoff from Irongate Road is currently collected on the grassed road verge prior to soaking away. The road verge has only minor contouring for drainage. The pervious nature of the soil and the minimal catchment area draining to the verge allows this arrangement to operate effectively. Development north of Irongate Road is expected to increase runoff to the northern side of Irongate Road. An upgrade of the swale on this side of the road will be required to allow effective drainage and to provide a secondary flow path. The southern side of Irongate Road is unlikely to receive additional runoff and therefore the existing drainage arrangement may be considered appropriate following development.

Runoff from Maraekakaho Road is also currently collected on the grassed road verge prior to soaking away. The road verge has only minor contouring for drainage. The pervious nature of the soil and minimal catchment area draining to the verge allows this arrangement to operate effectively. It is expected that runoff to the grass verge will remain relatively unchanged and therefore after development the existing drainage may be considered appropriate. It is unlikely that any significant swale or drainage upgrade along Maraekakaho Road would be required as a result of further industrial development along this road. Any upgrade of drainage along the road frontage required in the future can be addressed as required on a development by development basis.

There is a possibility that some of the stormwater that runs off Maraekakaho Road currently drains to the adjoining rural properties prior to soaking away, especially in the vicinity of the natural ponding area located adjacent to the intersection of Maraekakaho Road and Irongate Road.

It is expected that if this is found to be an issue in the future the Council will discuss this issue with the New Zealand Transport Agency prior to Maraekakaho Road Extension being passed back to the Council following the construction of the Southern Expressway Extension.

3.4 Proposed Southern Expressway

The assessment of stormwater options is made assuming the Hawke's Bay Southern Expressway Extension will be constructed as outlined in the "Southern Expressway Extension: Flaxmere to Longlands, Hydrologic and Hydrodynamic Analysis" report. In addition, it is assumed that the Sisson Drain realignment and proposed increase of the culvert under Maraekakaho Road are completed as described in this report. It is also assumed that any additional runoff from the expressway will be managed as part of the expressway extension development.

3.5 Existing Flooding Issues

3.5.1 Irongate Stream and Sisson Drain

The catchment areas of the Irongate Stream and Sisson Drain to Maraekakaho Road are 18km^2 and 6km^2 respectively.

The capacity in the Irongate Stream and Sisson Drain appears to be sufficient to prevent major flooding in the development area. Minor flooding has been indicated on flood extent maps provided by the Council. These maps are derived from information prepared by HBRC (see Appendix 3). This is shown at the lower extent of the development area adjacent to Sisson Drain. Flooding of the Irongate Stream and/or Sisson Drain within the plan change area does not appear to impose any significant constraint to development of the area.

However, discussions with HBRC have highlighted concerns about flooding around the Sisson Drain. As such restrictions on the future discharge from the Sisson Drain catchment development is needed in order to prevent existing flooding problems from getting worse. Meeting the design objectives and discharge restrictions described above would allow this to be achieved.

3.5.2 Karamu

The Karamu catchment is 440km^2, and is the major drainage and stormwater outlet for Hastings, Havelock North, much of the Heretaunga Plains and the surrounding hill country. The Karamu Stream has a history of flooding and now forms a significant part of the flood control scheme for the area.

The proposed development area represents just 0.2 % of the Karamu Catchment. While the actual affects of any increase in runoff from the development area on flooding in the Karamu Stream may be minor, the cumulative effect of similar developments throughout the whole catchment may be significant.

HBRC has indicated that the design and operation of the flood control scheme for the Karamu catchment has taken into account future development within the Irongate Stream and Sisson Drain catchments and their associated increases in discharge.

By meeting the design objectives as described above the potential increases in flows from the proposed new industrial area post-development will be less than that allowed for by HBRC in the design and operation of the flood control scheme for the Karamu catchment. Therefore potential increases in flows from the proposed new industrial area post-development at the Karamu can be considered to not have any adverse effect on flooding.

3.6 Aquifer Considerations

The land contained within the area proposed to be rezoned is over the Confined Aquifer as shown in Schedule Va of Regional Resource Management Plan (RRMP) – Heretaunga Plains unconfined aquifer.

Preliminary discussions with HBRC have, however, confirmed that stormwater quality is a sensitive issue for new industrial areas. It is considered likely that any future stormwater discharge consents for the area will require treatment of stormwater prior to disposal to land or the HBRC receiving drainage network. However, some consideration does need to be given to the current statutory provisions for stormwater discharges contained in the Hawke's Bay Regional Resource Management Plan, which are somewhat permissive in terms of requirements for treatment. It is understood that these statutory provisions are currently subject to review, which may address the current permissive regime in terms of requirements for treatment.

Design considerations have been progressed on the basis of a low impact design. This is consistent with the expected future approach to be taken by HBRC.

3.7 National Environmental Standard for Sources of Human Drinking Water

Sections 7 and 8 of the National Environmental Standard for Sources of Human Drinking Water (NES) are now particularly relevant to the consideration of solutions for the disposal of stormwater to land in the proposed new industrial area. These sections only apply to a discharge activity that has the potential to affect a registered drinking-water supply that provides no fewer than 501 people with drinking water for not less than 60 days of each calendar year. A list of the registered drinking water supplies in the District from 2003 that may be relevant to this assessment is contained in Appendix 4 of this report.

Under section 7 of the NES the Regional Council *may not grant a water permit or discharge permit for any activity that will occur upstream of an abstraction point where the drinking water concerns meets the health quality criteria if the activity is likely to:*

- *introduce or increase the concentration of any determinands in the drinking water, so that, after existing treatment, it no longer meets the health quality criteria; or*
- *introduce or increase the concentration of any aesthetic determinands in the drinking water so that, after existing treatment, it contains aesthetic determinands at values exceeding the guideline values.*

Section 8 governs discharges upstream of abstraction points for water supplies which have not had their drinking water tested or the supply does not meet the health quality criteria. In the case of supplies which have not been tested a Regional Council may not grant a water permit or discharge permit if the activity is likely to—

- *increase the concentration of any determinands in the water at the abstraction point by more than a minor amount; or*
- *introduce or increase the concentration of any aesthetic determinands in the drinking water so that, after existing treatment, it contains aesthetic determinands at values exceeding the guideline values.*

Where the water supply does not currently meet the drinking water standards a Regional Council must not grant a water permit or discharge permit if the activity is likely to—

- *increase, by more than a minor amount, the concentration of any determinands in the water at the abstraction point that in the drinking water already exceed the maximum acceptable values for more than the allowable number of times as set out in Table A1.3 in Appendix 1 of the Drinking-water Standard; or*
- *increase the concentration of any determinands in the water at the abstraction point that in the drinking water do not exceed the maximum acceptable values for more than the allowable number of times as set out in Table A1.3 in Appendix 1 of the Drinking-water Standard to the extent that the drinking water, after existing treatment exceeds the maximum acceptable values*

for more than the allowable number of times as set out in the Table in relation to those determinands; or

- *introduce or increase the concentration of any aesthetic determinands in the drinking water so that, after existing treatment, it contains aesthetic determinands at values exceeding the guideline values.*

It is also worth noting that under section 12 of the NES, if consent is granted for a discharge upstream of a registered drinking water supply that provides for no fewer than 25 people on not less than 60 days of the year, and there is a potential an event (such as a spill or heavy rainfall event) to have a significant effect on the quality of water at the water supply abstraction point, then the Regional Council must impose a condition on the consent. The condition must require the consent holder to notify the registered drinking water supply operator(s) that the event has occurred.

At this time it does appear that the potential for significantly impacting a registered drinking water supply as a result of disposal of stormwater to land in the proposed new industrial area will be limited. The disposal of stormwater to land in this area is likely to only have an effect where a downstream water supply is sourced from an unconfined aquifer or surface water body. The Heretaunga Plains unconfined aquifer as shown in Appendix 5 (Schedule Va of the Hawke's Bay Regional Plan) is upstream of the proposed plan change area meaning the only potential for impact would be on registered surface water takes where those takes are down stream in the Karamu River system.

Without detailed knowledge of the contaminates that may be discharged, their location or their concentration it is difficult to determine with any certainty at this time how the NES may impact on the feasibility of using land disposal options in the proposed new industrial area. However, based on the information that is known about the location of the future discharge points over the confined aquifer and the distance to the nearest registered drinking water supply sources, it appears unlikely that the NES will be a substantial barrier to the future industrial development this area. It does appear likely that suitable treatment could be used as an option to ensure that the disposal of stormwater to land in the future will achieve compliance with the NES. Further investigation at the time of development may be required to confirm this with still applies.

3.8 Consenting

The diversion and discharge of stormwater in industrial areas is managed under relevant rules contained in the Hawke's Bay Regional Resource Management Plan. Resource consents will be required for the diversion and discharge of stormwater to the Irongate Stream or the Sisson Drain from any constructed open drainage system or piped stormwater drainage system where:

- the site exceeds 2 hectares in area; or
- the site is used for the storage of hazardous substances; or
- the discharge causes a permanent reduction in the ability of the receiving channel to convey flood flows; or
- the discharge causes permanent bed scouring or bank erosion of the receiving channel; or
- the discharge causes the production of conscious oil or grease films, scums or foams, or floatable or suspended materials in the receiving waters after reasonable mixing.

The use of a reticulated stormwater solution for the proposed new industrial area with a specific discharge point to either the Irongate Stream or the Sisson Drain would require resource consent, as the reticulated system would drain industrial and trade premises covering a combined area of more than 2 hectares. It is likely that any such resource consent would be assessed as a Controlled Activity under the Regional Resource Management Plan. The Regional Council must approve a resource consent for a Controlled Activity but may impose appropriate conditions to avoid, remedy or mitigate any potential for adverse effects on the receiving environment.

The design objectives established for the management of stormwater within the proposed new industrial area provide a generally accepted basis for the avoidance or mitigation of the potential for adverse effects on the receiving environment. As such, there is a reasonable probability that resource consent will be able to be secured for the diversion and discharge of stormwater from the proposed new industrial area via a reticulated stormwater system in the future.

However, the likely resource consent requirements in relation to the onsite treatment and disposal of stormwater are a little less certain. It is possible that resource consents may not be required under the existing provisions of the Regional Resource Management Plan for site specific stormwater discharges where the future industrial site is not used for the storage of hazardous substances and does not exceed 2 hectares in area.

Despite the possibility of resource consents not being required for site specific stormwater discharges the relevant provisions contained in the Regional Resource Management Plan do provide some encouragement for an onsite stormwater management regime that reduces the rate of stormwater runoff to water courses and promotes the infiltration of stormwater into the ground.

The imminent review of the stormwater provisions contained within the Regional Resource Management Plan will provide an opportunity for the Regional Council to strengthen the incentives associated with the use of low impact design solutions for stormwater management. A stormwater management regime developed in accordance with the design objectives established for the proposed new industrial area would be consistent with any such approach.

4 Effect of Development on Stormwater Runoff

4.1 Hydrology

The time for rainfall from all of the catchment to reach the outlet is often described as the critical duration storm or storm that produces the largest peak flow. This duration when related to the catchment is often referred to as the time of concentration. The times of concentration of the various catchments in the area have been estimated as follows:

Table 2: Time of Concentration for Various Catchments

Catchment	Time of Concentration
Proposed plan change area – to Maraekakaho Road	1-2 hr
Sisson Drain – to Maraekakaho Road	2 hr
Irongate – to Maraekakaho Road	4 hr
Karamu Stream (approximate)	24+ hr

Rainfall in the area for various duration storms and return periods are shown in Table 2. The critical duration storm for the catchments in the immediate area (Sisson Drain catchment and Irongate Stream catchment) and that of the proposed plan change area are best represented by the 2 hour duration. The 2 hour duration storm and associated rainfall intensities are considered the most appropriate when determining peak flows from the proposed new industrial area.

Table 3: Rainfall for Plan Change Area (in mm, from TP19 + 16%)[1]

	Return Period, Years					
Duration (hr)	**2**	**5**	**10**	**20**	**50**	**100**
1	22	30	36	41	48	53
2	31	43	50	58	67	74
6	61	81	95	108	124	137
12	92	122	142	161	186	205
24	122	162	189	215	248	273
48	152	202	235	268	309	340
72	167	223	259	295	340	374

Climate change has been addressed as part of this assessment. A review of Ministry for the Environment guidelines[2] suggest an increase in rainfall intensities of approximately 16% would be appropriate to address climate change up to 2090. Rainfall depths in Table 3: Rainfall for Plan Change Area (in mm, from TP 19 + 16%) show the increased rainfall amounts which have been used for hydrological calculations.

[1] Following discussion with HBRC on the 2nd of December it was considered appropriate to use the rainfall depths from TP19. These rainfall depths may be considered conservative but allow comparisons with the Southern Expressway Extension: Flaxmere to Longlands, Hydrological and Hydrodynamic Analysis report prepared by Hawke's Bay Regional Council.

[2] Preparing for climate change – A guide for local government in New Zealand, Ministry for the Environment, July 2008.

The Rational Formula is considered appropriate for assessing catchments sizes similar to that of the proposed plan change area. The rational method was used to calculate peak flow discharges and is described as follows:

Q = 0.00278CIA

Q = peak discharge (m^3/s)
C = Runoff coefficient
I = Rainfall intensity (mm/hr)
A = catchment area in hectares

4.2 Current Situation

The soil type for the area consists of alluvial deposits from greywacke and/or sandstone. The current land use is largely pastoral with some areas of row crops and some areas of existing residential and industrial development. Estimates of runoff co-efficient for these areas are 0.20, 0.65 and 0.75 respectively.

Based on the above information a runoff coefficient of 0.30 has been selected.

As the selection of the predevelopment coefficient is critical in determining the effect the future industrial development may have on stormwater runoff, the acceptability of this coefficient was confirmed with HBRC. This coefficient was accepted as being reasonable.

Using the Rational Method the peak flow and volume for the whole of the plan change area for various events have estimated:

Table 4: Existing Peak Flow and Volume Estimates - Sisson Catchment

Return Period (Years)	Peak Flow (m3/s)	Volume (m^3)
5	2.29	16,500
10	2.67	19,200
50	3.09	22,300
100	3.41	24,500

For this high level assessment a single runoff coefficient has been assumed for simplicity. This is likely to overestimate for low return period events and under estimate for high return period events.

4.3 Proposed Development

The Hastings District Council Engineering Code of Practice gives a typical run off co-efficient for light industrial during a 50-year event as 0.75.

As with the predevelopment coefficient this coefficient is also critical in determining the effect that future industrial development may have on stormwater runoff. The acceptability of this was also confirmed with HBRC and was accepted as being reasonable.

Table 5: Proposed Development Peak Flow and Volume Estimates - Sisson Catchment

Return Period (Years)	Peak Flow (m3/s)	Volume (m^3)
5	5.73	41,300
10	6.66	48,000
50	7.73	55,700
100	8.53	61,400

4.4 Potential Increase in Flow and Volume

The potential increase in both peak flows and volumes is shown below.

Table 6: Potential Increase in Peak Flow and Volume Estimates - Sisson Catchment

Return Period (Years)	Peak Flow (m3/s)	Volume (m^3)
5	3.44	24,800
10	3.99	28,800
50	4.64	33,400
100	5.12	36,900

To prevent existing flooding problems from getting worse the peak flows, catchment areas and receiving environments need to be considered in detail and an acceptable concept stormwater design solution determined.

4.5 Longer Duration Storms

The critical duration storm for the catchments in the proposed new industrial area has been defined as 2 hour duration. While longer duration storms may produce greater runoff volumes at lower peak flows these would be unlikely to have significant effect on the peak flows or the flooding issues relating to the Sisson Drain at Maraekakaho Road.

5 On-site Stormwater Treatment and Disposal Options

The initial most feasible stormwater management solution for the proposed new industrial area was assumed to be onsite treatment and disposal given the soils found in the area. As such, the focus of initial consideration has been towards onsite treatment and disposal options. The following section describes the various on site options considered and gives indicative rough order costs for the various treatment and soakage options.

5.1 On-site Soakage Options

When assessing the soakage requirements and rough order costs two design parameters have been assumed. The first is to provide soakage to receive a 5-year storm without surcharging. The second is to provide soakage to receive a 50-year storm without surcharging. The original intention of the 50-year design parameter is to provide a soakage option that would not require a secondary flow path.

There are several soakage options available that could feasibly be used including:

- Dry wells
- Modular block porous pavement
- Rain gardens
- Swales and filter strips
- Infiltration trenches

An important element influencing the ability of soakage systems to operate effectively is the infiltration or soakage rate. Soakage test have been conducted throughout the plan change area. The rate overall may be considered to be very rapid. For this high level assessment, based on the infiltration test summarised in Table 7, a rate of 600mm/hour was selected to be used when determining soakage requirements. This rate is the lowest recorded in the sandy and gravely soil typical in the area. For silt or clay soils the rate is expected to be lower. Soil types and infiltration rates specific to individual development areas would need to be considered when undertaking detailed design where an on-site solution is used.

Table 7: Summary of Soil Soakage Tests Results

Soakage Test No.	General Description of Predominant Soil Type	Results (mm/hour)
1	Sandy fine to coarse GRAVEL	600 – very rapid
2	Fine SAND with occasional medium gravel	1,800 – very rapid
3	Gravely (fine to v. coarse) fine SAND	1,050 – very rapid
4	Gravely (fine to coarse) fine to medium SAND	600 – very rapid
5	SILT	240 – rapid

While several soakage and storage options would be available this assessment focuses of the use of infiltration trenches as the primary means of stormwater disposal in order to provide a feasible on-site option. See Appendix 7 for design assumption details.

In addition to soakage trenches onsite storage may be considered prior to soakage as could other soakage methods or a combination of methods. Other options may allow the soakage systems to work more efficiently and may reduce the soakage requirement and overall costs. These should be further investigated at the detailed design phase when specific site characteristics can be considered. However, for the purpose of this preliminary assessment, stand alone infiltration trenches are considered to be a good representative option.

5.2 On-site Soakage – Rough Order Costs

In determining the soakage requirements and rough order cost, soakage devices in the form of soakage trenches have been selected. Soakage trench requirements have been estimated for both a 5-year and 50-year service, one hour storm standard.

Table 8: Soakage Trench Indicative Costs for 5-Year and 50-Year Service Standards

Development Site Area	Peak Flow (m^3/s)	Approximate Minimum Site Area Required (m^2)	Indicative Cost (Soakage)
5-Year Soakage Standard			
1 hectares	0.06	480	$67,200
50-Year Soakage Standard			
1 hectares	0.10	750	$ 105,000

The approximate minimum percentage of site area required for on-site disposal of the 5-year one hour event through soakage trenches is 5%. The approximate minimum site area percent required for on-site disposal of the 50-year one hour event through soakage trenches is 7.5%. This allows for 50% site area additional to that contained by the soakage trench footprint. This should be considered the minimum area required. This area does not include provision for stormwater quality treatment. The required area for stormwater quality treatment is largely dependent on the type of treatment used and the treatment device chosen. It is likely a minimum of 3% of the development site area in addition to the area required for soakage will be needed for water quality treatment.

Indicative costs as indicated in Table 8 above do not include on site land cost that may be associated with provision of onsite treatment and disposal. It is anticipated that a significant portion of land area required for onsite treatment and disposal will make use of unutilised areas such as gardens, grassed areas or areas along boundaries. The land cost may vary significantly for each site and would be dependent on final site layout and design of any final onsite treatment and disposal option.

There are a number of management and maintenance issues regarding soakage systems as described in Section 5.5 below. While it is shown that onsite disposal of stormwater is a viable option it is highly likely that a secondary flow path either for larger than design events or blockage/failure of the on-site soakage systems would be required to compliment the on-site solutions.

5.3 Stormwater Treatment Options

As a minimum measure to prevent clogging, infiltration trenches would require a pretreatment device to settle larger solids. In addition to preventing clogging, the risk to groundwater contamination, though water quality treatment, would also be reduced.

Treatment options available include:

- Sedimentation
- Wetlands
- Filtration and absorption to filter material
- Biological uptake
- Biofiltration
- Flocculation
- Vegetative filter strips or swales

To allow an assessment of water quality treatment requirements and to estimate a range of costs, several treatment options have been reviewed. A vegetative filter strip stands out as the best representative method for providing stormwater quality treatment. This option would offer a lower level of treatment but may be considered acceptable for screening larger solids and sediment. This option is considered to be the minimum required to enable the infiltration trench to operate without clogging.

A vegetative strip may be combined with a collection trench or other mechanism for settlement of particles. This would require additional earth works but is unlikely to increase cost significantly over and above the filter strip. A collection medium for settlement of particles may improve treatment of water quality significantly. The level of treatment would depend on the size and design of the settlement mechanism.

Vault sand filters have been considered as a possible device to provide water quality treatment. Vault sand filters offer a high level of treatment but also have high costs. The treatment of the stormwater via vault sand filters would enable future industrial sites to mitigate any increase in the concentration of any determinates in stormwater discharge. Sand filters in forms other than vault filters may be appropriate but these have not been reviewed as part of this assessment.

See Appendix 7 for design assumption details.

The treatment of stormwater prior to discharge will enable future industrial sites to mitigate any increase in concentration of determinants. The type and level of treatment should be further investigated at the detailed design phase when specific site characteristics are known and the risk and/or level of potential contaminants are known.

5.4 Stormwater Treatment – Rough Order Cost

The tables below provide high level rough order costs for pre-soakage water quality treatment that are likely to be incurred at the time of site development. Assumptions have been made relating to the treatment and soakage practices used in order to determine indicative costs. However, individual site specific conditions should be considered when determining the preferred treatment and soakage practices.

Table 9: Water Quality Treatment Indicative Costs

Development Site Area	WQV (m^3)	Approximate Minimum Site Area Required (m^2)	Vegetative Filter – Indicative Cost	Vegetative Filter including Collection Trench – Indicative Cost	Vault Sand Filter – Indicative Cost
1 hectares	87.5	320	$43,000	$72,000	$136,000

5.5 Maintenance and Management Issues

The continual effective operation of on-site stormwater management devices relies on the application of effective maintenance and management procedures. The following maintenance requirements would likely ensure continued effective operation of on-site stormwater systems within the plan change area:

- Frequent checks to inspect stormwater management device, removal of obstructive growth and clearing of blockages.
- Engagement of a qualified service contractor to carry out 2-yearly inspections.
- Removal of coarse sediment from sediment traps or forbays.
- Eventual excavation of soils and/or gravels from infiltration trenches may be required.
- Sand filters may require cleaning via suction devices.

- Appropriate disposal of any sediment, sand or gravel removed from stormwater management devices.

- Consideration should be given during detailed design to the access requirements for maintenance of stormwater management devices.

If soakage systems are not maintained adequately the ability to discharge water to soakage is reduced significantly. At present there does not appear to be any statutory mechanisms that would insure adequate maintenance. Due to the uncertainty surrounding maintenance of soakage systems this assessment has considered the failure of soakage systems or reduction in soakage efficiency. To account for this, over design of soakage systems may help to insure sufficient soakage is provided. An indication of the design and cost required to achieve a 5-year design standard may be obtained by examining the 50-year soakage standard. Given poor maintenance and approximately 40% failure or reduction in soakage over the plan change area, the 50-year design standard may be considered an appropriate level of over design to ensure that overall a 5-year service standard is maintained throughout the plan change area.

6 Swale Options

While it is possible on-site treatment and disposal could be a viable means for disposal of stormwater within the plan change area it is recognised that larger than design events will occur and that a secondary flow path needs to be considered to address the risk of localised flooding of future industrial sites. For the Irongate Stream catchment the existing properties are in relatively close proximity to the Irongate Stream. Therefore, by utilising existing flow paths or the existing road reserve and discharging directly to the Irongate Stream an adequate secondary flow option would be provided.

The Sisson Drain catchment does not have the option of direct discharge of overland flows to the Sisson Drain. Therefore a designated flow path utilising graded swales to assist conveyance of flows to the Sisson Drain is required. In addition to protecting buildings and gully traps from inundation the secondary flow system may be used to provide stormwater quality treatment and some storage, which may attenuate flows, helping to meet the design objectives for the Sisson Drain catchment.

6.1 Swale Design Objectives

The primary purpose of the swale is to provide a secondary stormwater option through the Sisson Drain catchment. The secondary stormwater system is to protect buildings and gully traps from inundation. While the design standard in the Council's Engineering Code of Practice is for the 50-year event it is now recognised industry best practice to consider storm events up to the 100-year event. The concept swale design has allowed for the 100-year event.

However, detailed design considerations in relation to reinstatement of existing vehicle crossings over proposed swales have not been undertaken. These will either be constructed to the 100-year standard as provided by the swale or they may be constructed to a lesser standard. A lesser standard would restrict flow and may cause localised flooding. The detailed design of these elements can be finalised at the design and consenting stage. While it may not be necessary to design the elements to the 100-year standard the detailed design will need to consider any adverse flooding effects that such structures may cause.

A number of vehicle crossings currently exist along the swale proposed to be constructed along the western section of Irongate Road. The width of this section of swale has been increased to eight metres to allow design flexibility for the replacement of these vehicle crossings. It is also possible that vehicle crossings along the eastern section of Irongate Road may be needed in the future. To provide for design flexibility in the future for the addition of vehicle crossings the width of the swale has been increased to six metres.

See Appendix 6 for swale location and design details. This includes a summary of widths for various swale sections.

It is anticipated that any secondary stormwater and/or overland flow facilities would be provided and maintained by the Council.

See Appendix 7 for swale design assumptions.

7 Attenuation Area Options

Due to the identified flooding issues in relation to the Sisson Drain in the vicinity of Marakakho Road attenuation to control peak discharge is considered necessary. Attenuation areas can be provided in a number of forms. The decision on the type of attenuation area to be provided can be influenced by a number of factors. These factors include design objectives for water quantity and water quality, aesthetic values, ecological enhancement, safety and maintenance issues.

The three types of attenuation areas that have been considered are wet ponds, dry ponds and wetlands. A dry pond/attenuation area is considered the most appropriate given the design requirements and site characteristics. Alterations to this to allow for further water quality treatment and/or ecological values may be considered at the detailed design stage. A dry pond/attenuation area does however provide for the option of the land being used for grazing.

7.1 Attenuation Area Design Objectives

The primary objective of the attenuation area is to provide attenuation for control of peak flows to prevent flooding problems from getting worse with in Sisson Drain in the area around Maraekakaho Road.

The following recommendations relating to peak discharge as described in the Hawke's Bay Stormwater Management Guidelines – Stormwater Management have formed the design objectives for the attenuation area.

- Post development peak discharge for the 100-year storm is recommended to be limited to 80% of the pre-development storm.
- For intermediate storm control it is recommended that the 2-year and 10-year post-development peak discharge not exceed the 2 and 10-year pre-development peak discharge.

By using the peak discharge design objectives, as described above, and estimates of post development inflows, hydrographs were generated and used to estimate the volume of storage required for the attenuation area. See Appendix 7 for the design details in relation to the attenuation area.

8 Recommended Stormwater Management Solution

The following section outlines the recommended stormwater solution for the proposed new industrial area. The recommended stormwater solution has been reached after consideration of the broad benefits and costs of the most feasible options available for the management of stormwater in the proposed new industrial area.

8.1 On-site Treatment and Disposal

Considerable consideration has been given to onsite treatment and disposal options. Through detailed investigation of these options several issues of concern were highlighted. These included:

- Relatively high development costs in providing soakage to a 5-year design standard.
- Relatively high development costs in providing water quality treatment.
- Uncertainty about the potential contaminants leading to uncertainty in water quality treatment required and uncertainty relating to the risk of groundwater contamination.
- Uncertainty over the mechanisms available to ensure adequate maintenance issues. This opens the risk of future performance standards being compromised.
- Provision of secondary flow to mitigate potential flooding issues is still required which impacts significantly on overall costs.

To address these issues while still providing for a sustainable solution investigation was undertaken into providing on site disposal of roof water only. This option has the added benefit of providing for aquifer recharge as described by HBRC. It was accepted that a secondary flow option would be required and that this option would still be able to receive runoff over and above the design standard of any on site disposal system provided. Therefore the design standard for soakage was able to be reduced.

The design standard was reduced to 22mm/hr. This is equivalent to a 2-year event in a short duration storm but provides soakage up to a 100-year event in longer duration storms. This design standard is considerably less that those options described in Section 5 above.

A review of the existing industrial area at Omahu Road indicated roof coverage of approximately 25%. It is assumed that this will be representative of the typical roof coverage for future industrial activities in the plan change area. This roof coverage percentage was used as the basis for the infiltration design calculations.

The risk of contamination from roof water is significantly less for onsite disposal of roof runoff than hard standing areas in an industrial area. However, there is still some risk, which can be addressed through the use of suitable roofing materials. On the assumption that suitable roofing materials are used, it is likely that no water quality treatment would be required and therefore no treatment has been allowed for.

The option of on site disposal of roof runoff addresses many of the issues of concern listed above. In addition the soakage design standard was able to be reduced. Although the standard is reduced for the majority of storm events the total volume of rainfall from roof runoff would still be able to be discharged to soakage.

The estimated cost per hectare is approximately $17,000.00. The onsite disposal of roof stormwater would be applicable to both the Irongate Stream and the Sisson Drain catchments. It is, therefore, recommended that this level of on-site soakage for both catchments in combination with a reticulated secondary flow option via swales and attenuation for the Sisson Drain catchments be implemented.

8.2 Irongate Stream Catchment

8.2.1 Secondary Flow

8.2.1.1 Discharge to Irongate Stream

For the Irongate Stream catchment the existing properties are in relatively close proximity to the Irongate Stream. Therefore, by utilising the existing flow paths and discharging directly to the Irongate Stream an adequate secondary flow option can be provided.

An exception to this is the low lying area at the intersection of Irongate Road and Maraekakaho Road. This area does not have a readily available secondary stormwater option. As such, there is potential for low level flooding or ponding in the area. A possible design solution is a culvert under either Irongate Road or Maraekakaho Road to provide a secondary flow path. There may be some difficulties in providing such a culvert given the existing development and site restrictions in the area. However, there may be opportunities to incorporate a secondary stormwater solution for this area at the time the Maraekakaho Road and Irongate Road intersection is upgraded. The Council and the land owners would need to consider and agree on a suitable solution and cost sharing arrangement at the time the detailed design for the intersection upgrade is progressed. It is more appropriate for this issue to be addressed at the time of development through the subsequent resource consent or building consent processes given the uncertainties of development intentions for this area.

The receiving environment namely the Irongate Stream immediately downstream of the plan change area has no known significant flooding issues. Therefore control of peak flows from the Irongate Stream catchment is not considered a high priority.

Given the provision for onsite disposal of roof runoff and the absence of flooding issues in the receiving environment further restriction on peak flow discharge or provision of attenuation is not considered necessary.

8.2.1.2 Onsite Stormwater Treatment and Disposal of Larger Events

While it is envisaged that the secondary flow path to the Irongate Stream will be the primary means of disposal utilised by future developments in the Irongate Stream catchment, it is possible on-site treatment and disposal could be used as a viable alternative means for stormwater management. A number of issues of concern exist regarding on-site treatment and disposal as previously discussed. However, by incorporating site specific design on site solutions may be a viable alternative for selective sites within the Irongate Stream catchment.

8.3 Sisson Drain Catchment

8.3.1 Primary and Secondary Flow

8.3.1.1 Swales

The proposed secondary stormwater system for the Sisson Drain catchment is a Council owned and operated system including swales leading to an attenuation area prior to discharging to the Sisson Drain. The swales may have the dual purpose of providing water quality treatment and conveyance of flows up to the 100 year event.

The proposed swales option includes:

- A swale approximately 6 metres in width running along the boundary between stage one and stage two.
- A swale up to 8 metres in width running along the northern side of Irongate Road.

- A culvert under Irongate Road.
- A swale of width between 6 and 8 metres continuing to the attenuation area prior to discharging to Sisson Drain

See Appendix 6 for the recommended swale locations and design details.

A number of assumptions have been made relating to swale design. These include:

- Swale design has allowed for the 100 year rainfall event without free board.
- The design has not made allowance for vehicle crossings or reduced conveyance due to bends. These could cause reduced swale conveyance and may cause localised flooding in larger events. A contingency in terms of the width of the corridor for the swale has been provided to allow for options at the time of detailed design.
- Due to road safety issues where the proposed swale runs along Irongate Road and the proposed internal access corridor the design has incorporate 3.5 to 1 batter slopes.
- Where the swale does not run along a road a 4 metre wide access strip has been included. The design along these sections of swales has incorporated 2 to 1 batter slopes.

For further detail relating swale design assumptions see Appendix 7.

8.3.1.2 Attenuation

The primary objective of the attenuation area is to provide attenuation for control of peak flows to prevent flooding problems from getting worse with in Sisson drain in the area around Maraekakaho Road. To achieve this a number of restrictions relating to the peak discharge are required as previously mentioned. For the selected rezoning option and corresponding stormwater solution these include:

1. Post development peak discharge for the 100-year storm is recommended to be limited to 80% of the pre-development storm. For the selected rezoning option and corresponding stormwater solution this is 1.30m^3/s.
2. For intermediate storm control it is recommended that the 2-year and 10-year post-development peak discharge not exceed from the 2- and 10-year pre-development peak discharge. For the selected rezoning option and corresponding stormwater solution this is 0.55m^3/s and 0.87m^3/s.

Given these constraints and through the use of hydrograph routing the estimated required volume for the final attenuation volume is approximately 13,300m^3. This equates to an area of approximately 2 hectares being required for attenuation.

Details relating to the calculations of attenuation volumes and associated design assumption are contained in Appendix 7.

For Stage – 1 the final attenuation volume is approximately 1,800m^3. This equates to a land area of approximately 0.35 hectares being required for attenuation.

The proposed attenuation area is to be a dry pond formed by construction of a bund above the current ground level to provide storage.

As indicated the attenuation area required for the final zoning option and corresponding stormwater solution is approximately 2 hectares.

The design approach when determining the area required for the attenuation area included the following assumptions:

- A bund providing a depth 0.5 metres storage above the existing ground level is to be provided.
- In addition the attenuation area will be excavated to an average depth of 0.5 metres, thus giving an average depth of storage of 1 metre.

Sufficient contingency has been allowed for in determining the final area requirement. Allowance has been made for the construction of bunds, forebay, access and maintenance.

8.4 Rezoning and Staging Scenarios

To assist the determination of the extent of the plan change area four rezoning and staging scenarios have been considered and rough order costs have been estimated based on the recommend stormwater management solution for the proposed new industrial area. The four rezoning and staging scenarios are based on those areas shown on the Proposed Plan Change Area attached as Appendix 1.

The first three options are based on the rough order costs for the construction of the stormwater infrastructure (including land purchase costs) to the level required to service the areas to be contained in Stage 1, and then the additional rough order costs for the upgrade of the stormwater infrastructure (including the additional land purchase costs) to the level required to service the areas to be contained in Stage 2, once these areas are released for development (which is expected to be approximately 10 years after the release of Stage 1).

The fourth option is based on the rough order costs for the construction of the stormwater infrastructure (including all land purchase costs) to the level required to service both the Stage 1 and the Stage 2 areas prior to the proposed new industrial area being released for development.

Table 10 summaries the four options considered for the estimation of the rough order costs. The areas considered within Stage 1 and Stage 1 + only relate to those areas that are contained within the Sisson Drain catchment. Stage 2 and Area (c) are both contained entirely within the Sisson Drain catchment.

Table 10: Summary of Options

Option	Option Description	Total Cost
Option 1	Stage 1 and then Stage 2 at 10 years plus	**$1,951,500.00**
Option 2	Stage 1 and Stage 1+ and then Stage 2 at 10 years plus	**$2,251,800.00**
Option 3	Stage 1 and Stage 1+ and Area (c) and then Stage 2 at 10 years plus	**$1,850,100.00**
Option 4	Stage 1 and Stage 1+ and Area (c) and Stage 2	**$1,587,200.00**

Detailed rough order costs for the four options are shown in Appendix 8.

Option 1, Option 2 and Option 3 require construction of infrastructure in two stages firstly to provide for Stage 1 (and the other various area components) and secondly to provide for Stage 2. The increase in cost due to inefficiencies when constructing the infrastructure in two stages is noted. In addition as Option 1 and Option 2 require the attenuation area to be constructed in the proposed pane change area the land cost are significantly higher than for Option 3 and Option 4. Land cost for the attenuation area for Option 1 and Option 2 are $\$50/m^2$ while land costs for Option 3 and Option 4 are $\$5/m^2$. This has significant impact on total costs as shown in Appendix 8.

These rough order costs do not however make any provision for interest and holding costs.

8.5 Confirmed Stormwater Solution and Rough Order Costs

The swale and attenuation concept design for the selected rezoning option has been confirmed based on the recommended stormwater management solution outlined above. The confirmed stormwater solution is shown on the Stormwater Management Solution Concept Plan contained in 6.

A number of refinements have been made relating to final areas, attenuation area and depths and road and swale widths. The rough order costs for the recommended concept stormwater solution have been determined based on the refinements made once the rezoning option was selected. These rough order costs for the final recommended stormwater solution are summarised below with further detail shown in Appendix 8.

Table 11: Rough order of costs

Design and Construction Costs – Stage 1	Land Purchase Costs – Stage 1	Land Area Required – Stage 1	Sub Total – Stage 1	Stage 2 at 10 Years				
				Additional Design and Construction Costs	Additional Land Purchase Costs	Additional Land Area	Sub Total Stage 2	Total – ROC
$291,700	$539,700	1.39	$831,400	$436,800	$ 211,400	1.98	$648,200	**$1,479,600**

Note: Rough order cost are considered to be accurate to + or - 30%

9 Conclusions and Recommendations

The overall conclusions from the stormwater option assessment for the proposed Irongate Industrial Plan Change are as follows:

- The provision of a technically feasible stormwater management solution for the proposed new industrial area, using a low impact design approach while meeting both the HDC and HBRC design guidelines, is achievable. Such an approach is likely to incur development costs at the time of construction and commission and at the time of subdivision and development as outlined in this assessment.

- The low lying area at Irongate Road and Maraekakaho Road intersection does not have a readily available secondary stormwater option. As such, there is potential for low level flooding or ponding in the area. A possible design solution is a culvert under either Irongate Road or Maraekakaho Road to provide a secondary flow path.

- Onsite treatment and disposal has been shown to be a viable option for disposal of stormwater. However, several issues of concern have been highlighted. These include:

    - Relatively high development costs in providing soakage to a 5-year design standard.
    - Relatively high development costs in providing water quality treatment.
    - Uncertainty about the potential contaminants leading to uncertainty about the level of water quality treatment required and uncertainty relating to the risk of groundwater contamination.
    - Uncertainty over the mechanisms available to ensure adequate maintenance. This opens the risk of future performance standards being compromised.

  To addresses these issues and still provide for a low impact option which allows for groundwater recharge it is recommended that onsite disposal of roof water is included for both the Irongate Stream catchment and Sisson Drain catchment.

- The recommended Stormwater Solution includes:

    1. Onsite soakage systems receiving roof runoff in both the Irongate Stream catchment and the Sisson Drain catchment.
    2. Council owned and operated system of swales providing a primary and secondary flow for yard and road runoff for the Sisson Drain catchment for flows up to the 100 year event.
    3. Council owned and operated attenuation area to control peak flow discharge from the Sisson Drain catchment.

- Localised flooding issues in the vicinity of Sisson Drain at Maraekakaho Road/crossing have been identified. To achieve the design principle of ensuring that existing flooding problems do not get worse an attenuation area is proposed. The provision of an attenuation area to meet this objective has been shown to be technically feasible and is likely to incur development costs as outlined in the assessment.

- Flooding of the Irongate Stream and/or Sisson Drain does not appear to impose any significant constraint to development of the proposed new industrial area.

Appendix 1 – Proposed Plan Change Area

Appendix 2 – Catchment Areas and Secondary Flow Path

Appendix 3 – Flood Extents

Appendix 4 – Registered Drinking Water Supplies in the District from 2003

Appendix 5 – Confined and Unconfined Aquifer Areas

Appendix 6 – Swale Location and Designs Details

Appendix 7 – Design Assumptions

Soakage Design Assumptions

- For this high level assessment, based on the infiltration test summarised in Table 7 (Pg 12), a rate of 600mm/hour was selected when determining soakage requirements.
- When determining the minimum site area for soakage system. The soakage foot print has been multiplied by 1.5.
- All roof runoff is to be directed to soakage. The roof area is assumed to be 25% of the total site.
- Soakage gives greatest cost/benefit in terms of total groundwater recharge when designed for lower intensity or longer duration event. The design standard chosen is for the 6 hour 100 year event. The intensity of this event is approximately 22mm/hr
- For shorter duration events the capacity of the soakage system will be exceeded. For a 1hr event the soakage system will only be able to take the 2 year event. For a 2hr event the soakage system will have capacity to take the 5 year event.

<u>Reduction in total runoff used for attenuation design</u>

When determining the runoff from the site soakage needs to be taken into account. As the soakage system has not been design to take all of the 2hr 100year event the area cannot simply be reduced by 25% to determine the runoff.

To calculate the amount of runoff the area has been reduced to allow for soakage.

The 2hr event requires 86m^3/hr per hectare of discharge to ground from the roof.
The soakage system has been design to discharge 57m^3/hr per hectare. The ratio of ground water discharge to required discharge is 68%. It may have been appropriate to use this ratio when determining the area contributing to runoff.

Total roof are (25%) * soakage efficiency (68%) = 17%

However two other points are note when considering roof runoff

1. A runoff coefficient from the roof of 1 has been used. This is greater than the 0.75 used for the developed site.
2. The soakage system will have an element of storage which has not been taken into account by the above ratio.

To allow for this the 17% has been increase marginally to 20%.

Costs include preliminary and general (10%), investigation and designs (15%), contingency (25%).

Water Quality Design Assumptions

Components of Stormwater Treatment

When determining initial design requirement (5-year event, not roof water only option) for soakage options the following components of stormwater runoff treated as follows:

- Stormwater from roof areas – no treatment assuming specification of paint and roof cladding materials which minimise contamination;
- Stormwater from yard areas free from significant contamination – no treatment;
- Stormwater from yard areas with potential sediment and non-toxic organic contamination – on-site detention treatment;
- Stormwater contaminated by process activities – stormwater handled as wastewater and disposed to the HDC reticulated wastewater system with control on flow rate;
- Stormwater runoff from roads in the vicinity of the development zone – treatment via grass swales and shallow detention.

To allow a uniform assessment of water quality treatment requirements and to provide costs, water quality treatment of runoff from 50% of the industrial site has been assumed. This estimate may be considered conservative and it is possible that treatment of runoff of less than 50% would be required.

Water Quality Volume

- The size of the stormwater runoff event to be captured and treated is a critical factor in the design of stormwater quality treatment practices. It has been indicated in the Draft Stormwater Management Guidelines for the Hawke's Bay Region that the stormwater treatment should capture runoff volume of approximately the 90-percentile storm (water quality storm). The 90-percentile storm (water quality storm) is the storm that 90% of all storms on an annual basis are less than.

- The 90% rainfall event depth (water quality storm) for the area in question taken from the HBRC Stormwater Management Guidelines is 17.5mm. This compares to 25mm typical in the Auckland area, which have determined the capability of many treatment devices.

To determine the water quality volume storage the following calculations are required.

The first flush volume $V_{wq} = 10 \times A_{eff} \times d_{ff}$ (m^3)

Where:

d_{ff} = first flush water quality depth (water quality storm)

A_{eff} = the catchment effective first flush runoff area = impervious%/100 x total Area (ha)

Costs include preliminary and general (10%), investigation and designs (15%), contingency (25%).

Swale Design Assumptions

Swales

- Swales design has allowed for the 100 year rainfall event without free board. When determining the design flows a conservative approach has been taken and a 1 hour time of concentration has been assumed. The design has not made allowances for crossings or reduced conveyance due to bends. These could cause reduced swale conveyance and may cause localised flooding in larger events.

- A reduction in swale design flows due roof runoff to soakage has not been allowed for.

- As runoff from larger events will go through swales a stability check has been performed to ensure that the 10-year, 1-hour storm does not cause erosion. Swales have been checked to ensure that for the 10-year storm, flow velocities would not exceed 1.5 m/s.

- It is possible that a larger than design event will occur. As the swale generally follows natural falls across the site runoff is expected to naturally fall towards the defined secondary flow paths with minimal surface flooding. When the capacity of the secondary flow paths is exceeded flooding in the immediate vicinity of the secondary flow paths may be expected. The areas most susceptible to flooding would be the northern side of Irongate Road and low laying areas in the vicinity of the Sisson Drain.

- Swales may be used to provide attenuation however this would not be fully effective. The assumption that 50% of the total swale volume would be effective in providing attenuation has been made.

- Swale cross section have assumed a constant 1 metre base width; 2 to 1 and 3.5 to 1 side slopes. The depths have been varied to allow sufficient capacity for design.

- Manning's equation has been used to determine swale capacity the following assumption are made when calculating capacity:

    - Manning's equation used as follows:
      V = k/n*Rh^(2/3)*S^(1/2)
      Rh = A/P
      K=1
      Q=V*A
    - n (maning's n) = 0.03 (excavated weedy)
    - s (slope) = 1.25/800 (average/typical slope from Lidar data)

- The costs are largely determined by the volume of works required and the per m^3 rate applied. For swale construction the per m^3 rate ranges from $25/m^3$ to $\$30/m^3$.

- Costs include preliminary and general (10%), investigation and designs (15%), contingency (25%).

Attenuation Area Design Assumptions

To achieve HBRC requirements a multi staged discharge is required. To determining the storage requirement for a single storm event and single required discharge requires a series of calculations. However determining the storage for a three staged discharge increases the complexity of these calculations. To accurately determine the storage volume requirement a discharge hydraulic model may be required.

The attenuation area has been design to achieve the following:

1. Discharge for the 2y and 10y event match the existing.

2. Discharge for the 100y event is 80% of the existing.

In order to obtain an estimate for the three stage discharge approach some assumptions are required. These include:

1. 50% of the storage for the attenuation of the 2 year event can be used as effective storage for the 10 year event.

2. 50% of the effective storage for the 10 year event can be considered effective storage for the 100 year event.

3. Swales may be used to provide attenuation however this would not be fully effective. The assumption that 50% of the total swale volume would be effective in providing attenuation has been made.

- The cost for the attenuation area includes a bund 0.8 metres high, 1.5 metre crest and 3 to 1 side batters.

- In addition to providing storage through a bund it is proposed that the attenuation area is excavated to an average depth of 0.5 metre.

- As there are two stages the individual areas for attenuation have been calculated separately.

  - Stage 1 = 0.35ha
  - Stage 1 + Stage 2 = 2ha

  (These areas include approximately 20% additional land area for access, fencing, forebay, possible water quality treatment and contingency.)

- For bund construction relating to the attenuation area a rate of $55/m^3 has been assumed.

- The rate for excavation and removal of material within the attenuation area is $55/m^3 has been assumed.

- Costs include preliminary and general (10%), investigation and designs (15%), contingency (25%).

Appendix 8 – Stormwater Options 29th June (Update)

Appendix 9 – Selected Rezoning Stormwater Option

Selected Rezoning – Stormwater Option
Rough Order Costs

Swale Design and Construction Costs	Attenuation Design and Construction Costs	Land Purchase Costs - Swale	Land Purchase Costs – Attenuation	Land Area Required – Swale (ha)	Land Area Required – Attenuation (ha)	Sub Total Stage 1	Stage 2 at 10 Years						Sub Total Stage 2	Total
							Additional Swale Design and Construction Costs	Additional Attenuation Design and Construction Costs	Additional Land Purchase Costs - Swale	Additional Land Purchase Costs - Attenuation	Additional Land Area Required - Swale	Additional Land Area Required - Attenuation		
$ 205,100	$ 86,600	$ 522,300	$ 17,400	1.04	0.35	$831,400	$ 285,600	$151,200	$ 124,900	$ 86,500	0.25	1.73	$648,200	**$1,479,600**

Note: Rough order cost are considered to be accurate to + or - 30%

Area Serviced		Total Area Serviced with Stage 2 Included
Stage 1	Stage 2 at 10 Years	
11.15	41.4	52.55

On site Soakage

On site soakage has be designed to receive all roof runoff up to 22mm/hr.
This intensity is equivalent to a 100 year event with a 6 hour storm duration.
It is assumed that each site has 25% roof cover.
Cost estimates for a trench system have been made at approximately **$16,650.00** per hectare.

Stormwater Options – 29 June (update)
Rough Order Costs

Option	Swale Design and Construction Costs	Attenuation Design and Construction Costs	Land Purchase Costs - Swale	Land Purchase Costs – Attenuation	Land Area Required – Swale (ha)	Land Area Required – Attenuation (ha)	Sub Total Stage 1	Stage 2 at 10 Years						Sub Total Stage 2	Total
								Additional Swale Design and Construction Costs	Additional Attenuation Design and Construction Costs	Additional Land Purchase Costs - Swale	Additional Land Purchase Costs - Attenuation	Additional Land Area Required - Swale	Additional Land Area Required - Attenuation		
Option 1	$ 166,700	$ 101,900	$ 550,200	$ 296,500	1.10	0.59	$1,115,300	$311,700.00	$206,700.00	$181,900.00	$136,100.00	0.36	2.7	$836,400.00	**$1,951,700.00**
Option 2	$ 203,400	$ 131,500	$ 550,500	$ 530,500	1.10	1.06	$1,415,900	$311,700.00	$206,700.00	$181,900.00	$136,100.00	0.36	2.7	$836,400.00	**$2,252,300.00**
Option 3	$ 240,100	$ 152,600	$ 550,200	$ 70,800	1.10	1.42	$1,013,700	$311,700.00	$206,700.00	$181,900.00	$136,100.00	0.36	2.7	$836,400.00	**$1,850,100.00**
Option 4	$ 421,700	$ 235,500	$ 732,000	$ 198,000	1.46	3.96	$1,587,200	$0	$0	$0	$0	None	None	0	**$1,587,200.00**

Note: Rough order cost are considered to be accurate to + or - 30%

Option	Option Description	Area Serviced		Total Area Serviced with Stage 2 Included
		Stage 1	Stage 2 at 10 Years	
Option 1	Stage 1	11.15	38.2	49.35
Option 2	Stage 1 and Stage 1+	18.95	38.2	57.17
Option 3	Stage 1 and Stage 1+ and Area (c)	25.25	38.2	63.45
Option 4	Stage 1 and Stage 1+ and Area (c) and Stage 2	63.45	63.45	63.45

On Site Soakage
On site soakage has be designed to receive all roof runoff up to 22mm/hr.
This intensity is equivalent to a 100 year event with a 6 hour storm duration.
It is assumed that each site has 25% roof cover.
Cost estimates for a trench system have been made at approximately **$16,650.00** per hectare.

LEGEND

- STAGE 1 (IRONGATE INDUSTRIAL AREA)
- STAGE 2 (IRONGATE INDUSTRIAL AREA)
- ATTENUATION AREA
- IRONGATE STREAM
- SUB-CATCHMENT BOUNDARY
- INTERNAL ACCESS CORRIDOR
- SWALES

Swale Section	Swale Width – Stage 1	Swale Width – Stage 2	Total Width Provided For Swale	Batter Slopes	Maintenance Access Required	Swale Length	Final Design Flow m^3/s
A	5.2m	5.2m	5.5m	2:1	Yes – 4m wide	265m	0.97
B	Not required	8.0m	8.0m	3.5:1	No - road	374m	1.67
C	5.2m	5.2m	6.0m	3.5:1	No – road	190m	0.83
D	6.6m	8.0m	8.0m	3.5:1	No – access corridor	208m	3.66
E	5.0m	6.2m	6.5m	2:1	Yes – 4m wide	171m	4.33
F	5.8m	7.0m	7.0m	2:1	Yes – 4m wide	443m	5.87

REV	REVISIONS	DRAWN	CHECKED	APPROVED	DATE
A	CONCEPT PLAN	PC	TG		06/09

	Name	Date
SURVEYED		
DESIGNED		
DESIGN CHECK		
DRAWN	P.CHILTON	06/09
DRAWING CHECK		
APPROVED BY P.M	T.GRACE	06/09

MWH

HASTINGS DISTRICT COUNCIL

HASTINGS DISTRICT COUNCIL
IRONGATE INDUSTRIAL PLAN CHANGE

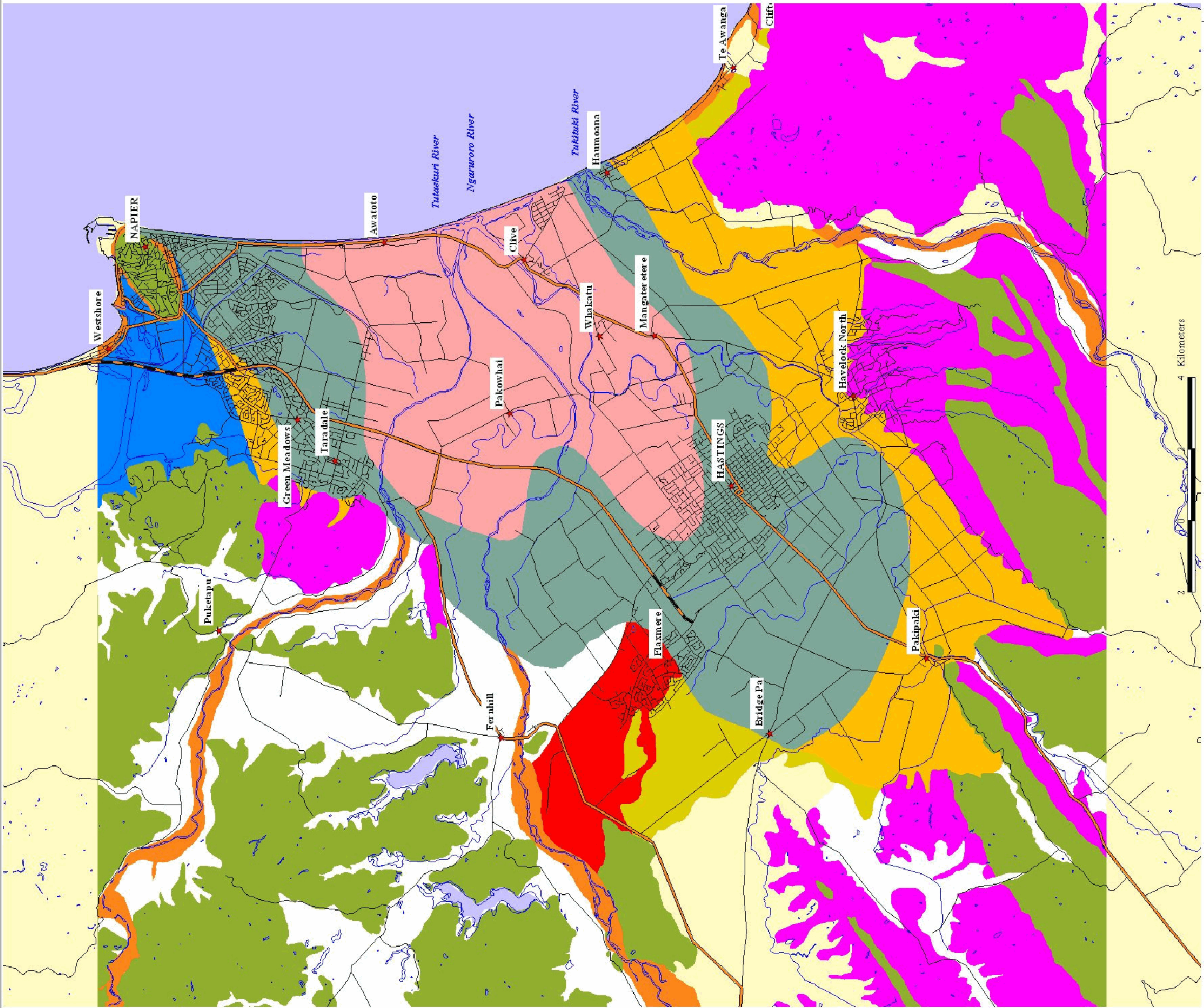
STORMWATER CONCEPT PLAN

Status Stamp: CONCEPT PLAN
Date Stamp: 19/06/2009
SCALES (A1) NTS
Drawing No. Z1462302 | Sheet No. C301 | Rev. A

XREFS : Irongate Industrial Expansion Option 8b

DO NOT SCALE - IF IN DOUBT, ASK

ORIGINAL SIZE A1



LEGEND

- Placenames
- Railway
- Main Highways
- Regional Roads

Most vulnerable

Least vulnerable

Kilometers
4
2
0
2

RELIABILITY: Modified DRASTIC factors is derived from mapping at 1:50,000 scale and should not be relied upon for measurements at scales larger than this.

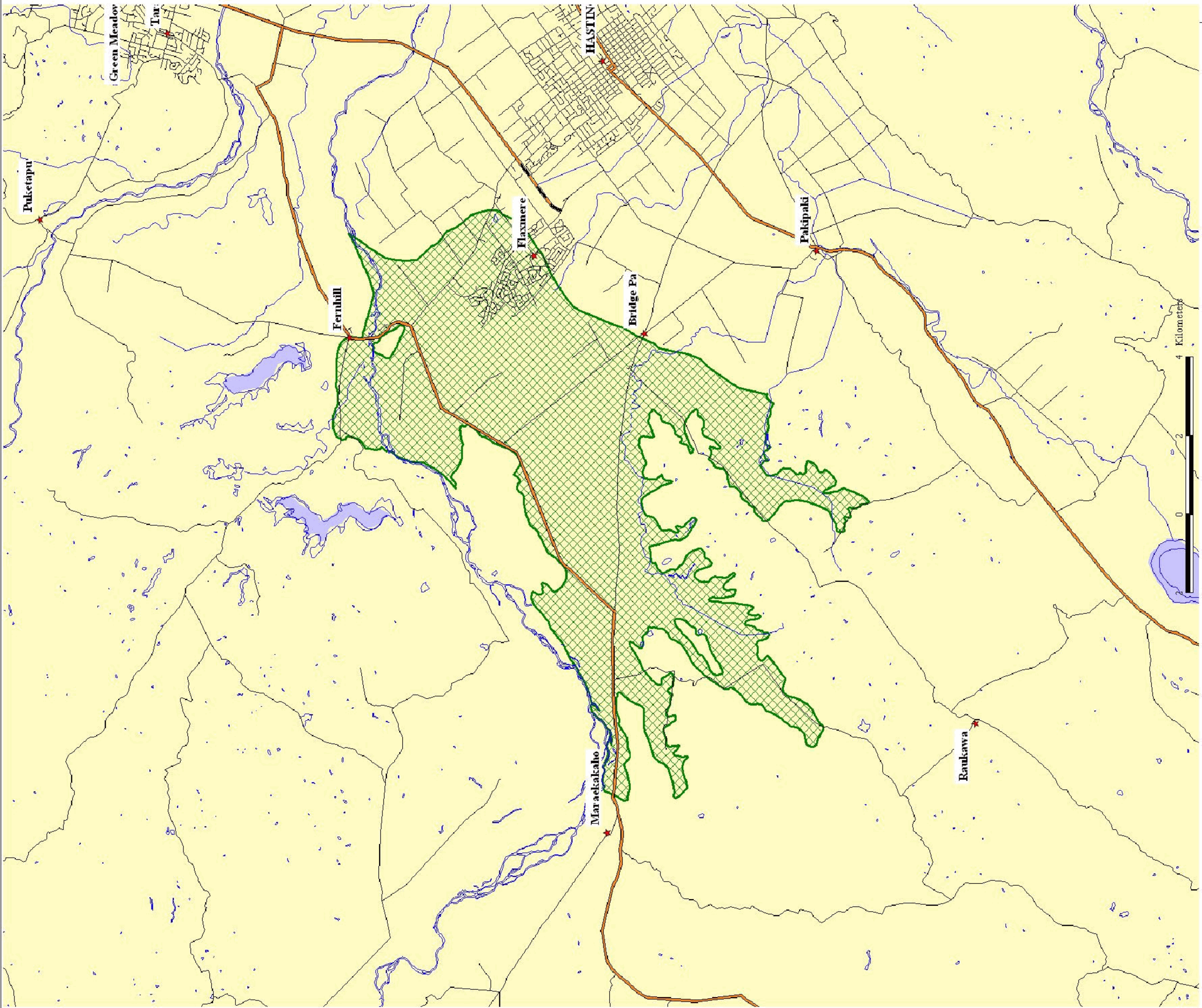
DATA FROM: DRASTIC factors obtained from the Hawke's Bay Regional Council Geographic Information System.

Cadastral Information and Digital Terrain Information obtained from Land Information New Zealand.

HAWKE'S BAY
REGIONAL COUNCIL

RESOURCE MANAGEMENT PLAN

Schedule V
Heretaunga Plains
- Contaminated vulnerability based on specifically modified DRASTIC factors for confined aquifers.



LEGEND

- Placenames
- Railway
- Main Highways
- Regional Roads
- Unconfined aquifer

RELIABILITY: Unconfined aquifer is derived from mapping at 1:50,000 scale and should not be relied upon for measurements at scales larger than this.

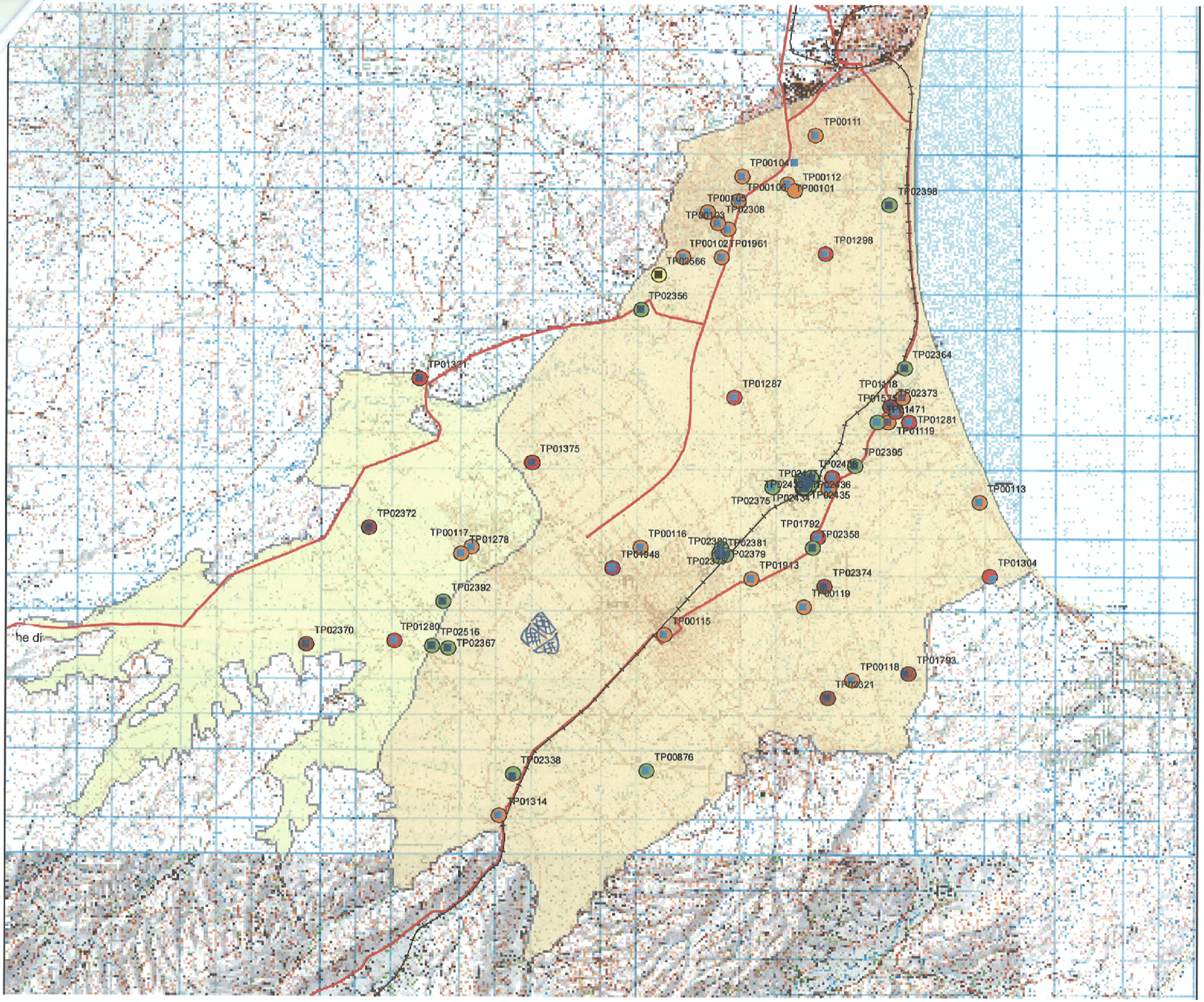
DATA FROM: DRASTIC factors obtained from the Hawke's Bay Regional Council Geographic Information System.

Cadastral Information and Digital Terrain Information obtained from Land Information New Zealand.

HAWKE'S BAY REGIONAL COUNCIL

RESOURCE MANAGEMENT PLAN

Schedule Va
Heretaunga Plains
unconfined aquifer



Legend

HP_Drinking_Water_Source

WZSourceTy

- Spring
- Unknown
- Well (confined)
- Well (unconfined)

HP_Drinking_Water_plant

OwnerType

- Health
- Hospitality
- Local Auth
- Marae
- Private
- School

HB_Aquifers

TYPE

- confined
- unconfined

Irongate Indus. Area

Information Map

Drinking Water Supplies Heretaunga Plains

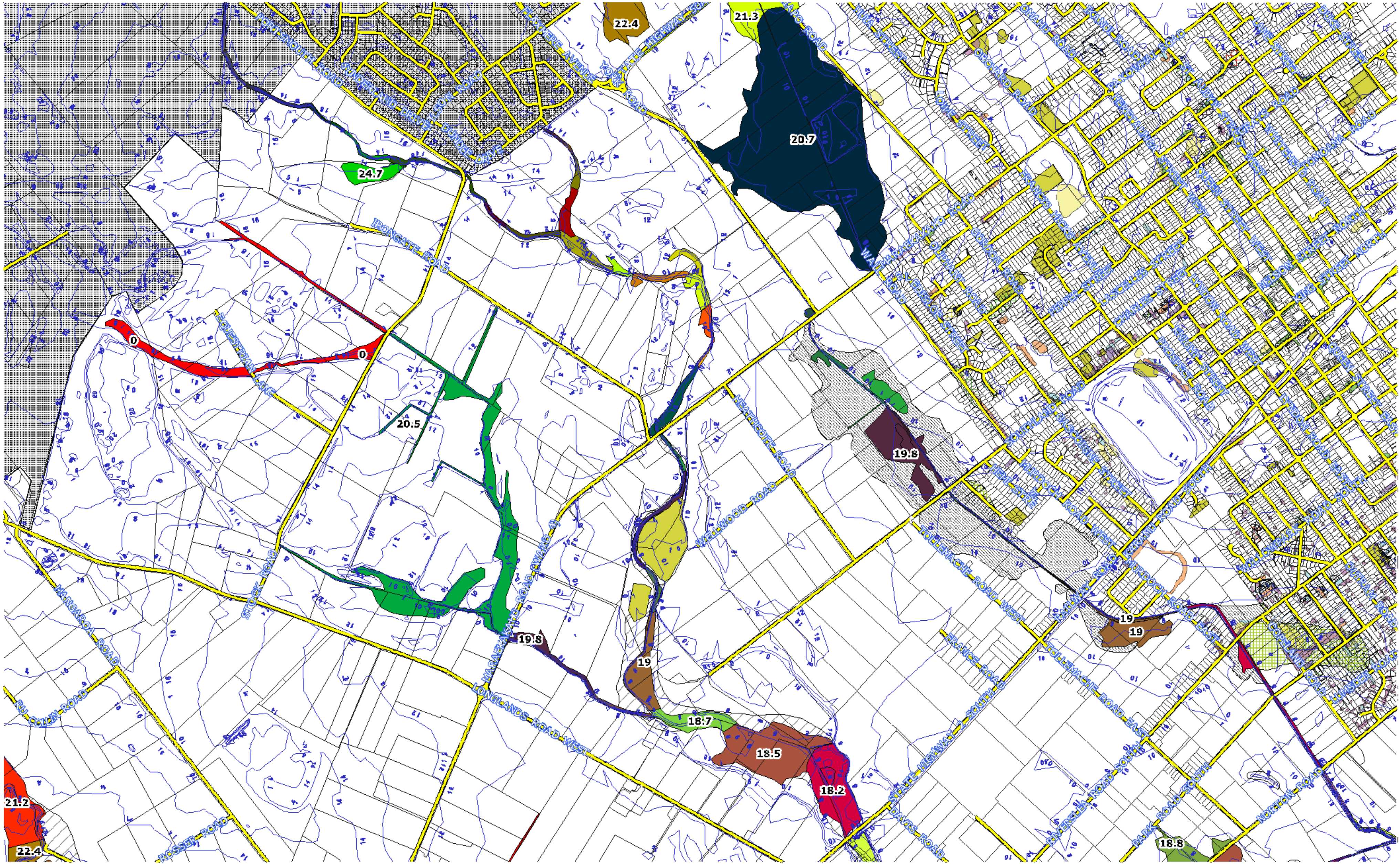
N

1:100,000

HAWKE'S BAY REGIONAL COUNCIL

DATA FROM: Drinking water information (Water source & Water plant) obtained from Ministry of Health.
Copyright Ministry of Health.
Aquifer information from the HB Regional Council.

DISCLAIMER
The Hawke's Bay Regional Council cannot guarantee that the



HASTINGS DISTRICT COUNCIL

Grid: New Zealand Map Grid
Height Datum: Mean Sea Level
Coordinates in Metres
Geodetic Datum 1949

Date : Wed Oct 29 2008

Scale 1 : 18891 (on A3)

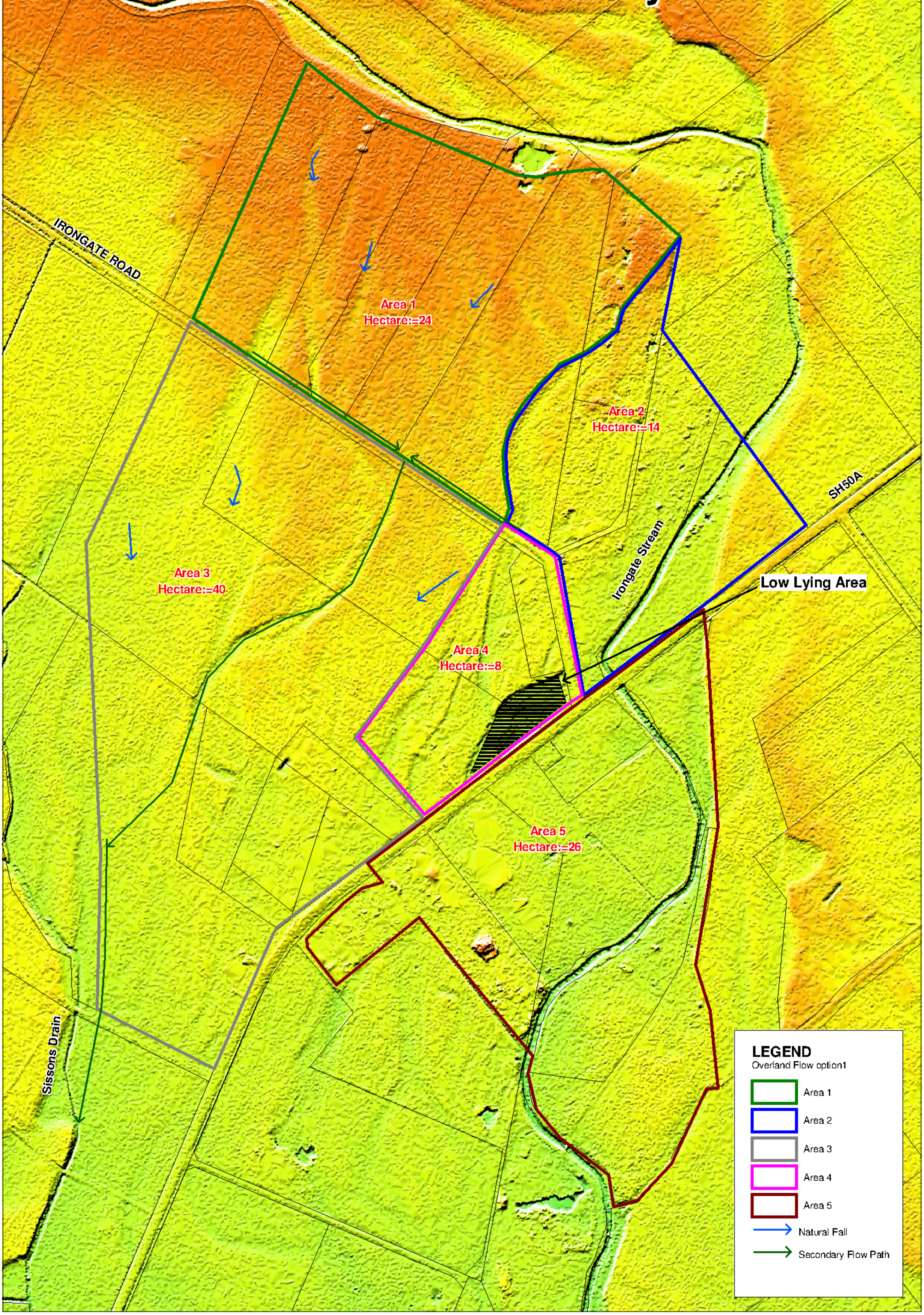
188.91 0 188.91 377.82 566.73 755.64

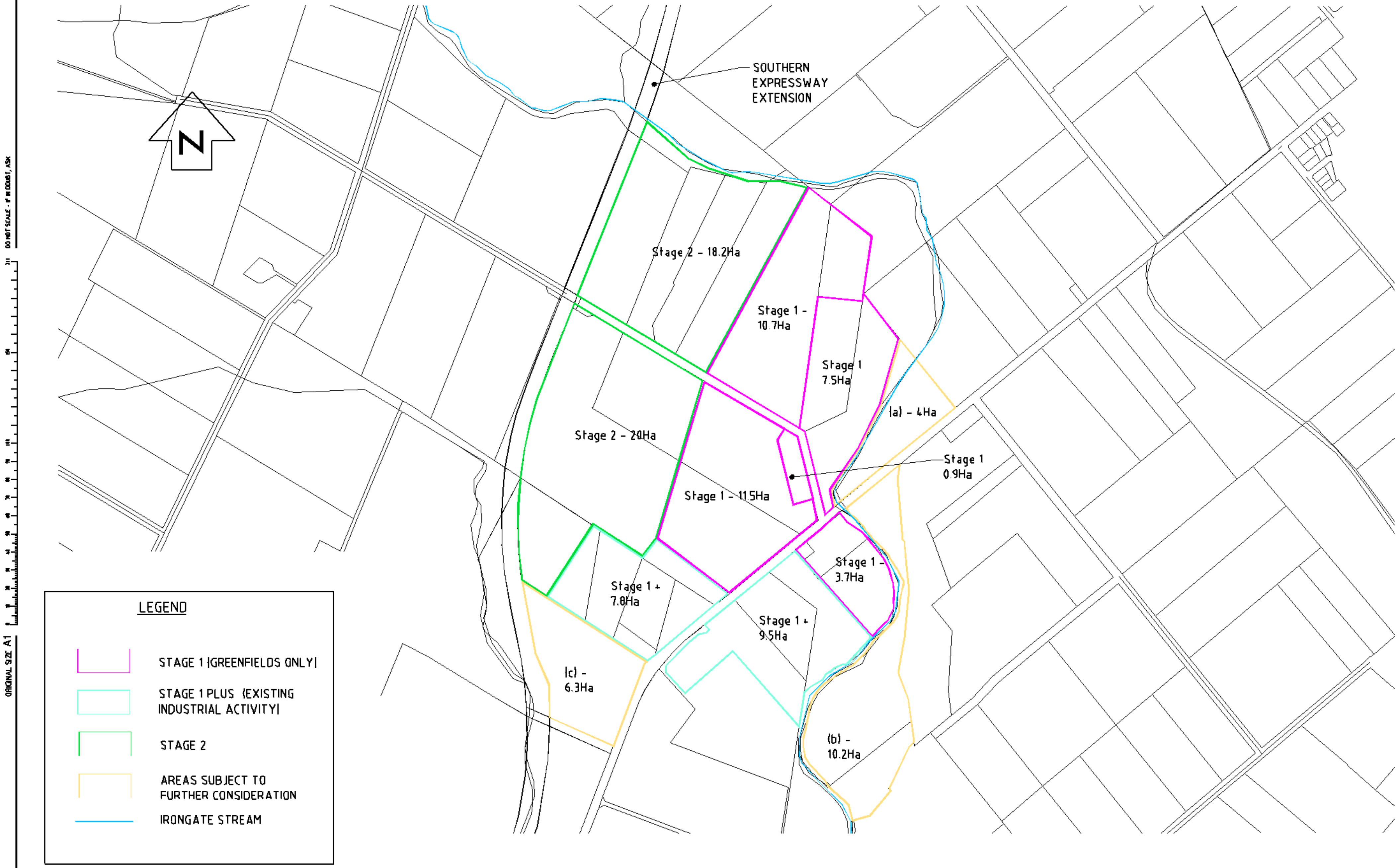
Metres

DATA SOURCE
Cadastral information derived from the Land Information New Zealand's Core Record System (CRS)
CROWN COPYRIGHT RESERVED

DISCLAIMER
The Hastings District Council cannot guarantee that the data shown on this map is 100% accurate

Catchment Area and Secondary Flow Path





REV	REVISIONS	DRAWN	CHECKED	APPROVED	DATE
A	REPORT - APRIL 2009	AP	MAH	TG	04/09

	Name	Date
SURVEYED		
DESIGNED		
DESIGN CHECK		
DRAWN	P.CHILTON	04/09
DRAWING CHECK		
APPROVED BY P.M.	TG	04/09

MWH

HASTINGS DISTRICT COUNCIL

HASTINGS DISTRICT COUNCIL
IRONGATE INDUSTRIAL PLAN CHANGE

FINAL STAGING PLAN

Status: **PRELIMINARY**
Date: 29/04/2009
SCALES (A1) NTS
Drawing No. Z1462302 | Sheet No. C 101 | Rev. A

XREFS :

\\nzhas1s01\projects\Z14800 Upwards\Z14623\Z1462302 - Irongate Industrial Plan Change\CAD\Plan Views_2.dwg